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ABSTRACT

Stomach contents of 42 species in 25 familes of Easter Island shore fishes were examined in comparative terms to determine prey items and feeding behavior at this isolated island outpost in the southeastern Pacific. The island's impoverished marine fauna and flora have resulted in considerable dietary overlap among the inshore fishes. Some endemic species appear to feed mainly on endemic invertebrates. Some prey species which were found in the fish stomachs, such as the stomatopod *Odontodactylus hawaiiensis,* the pandalid shrimp *Plesionika edwardsi*, and several tiny molluscs were previously unrecorded for the island.

INTRODUCTION

Easter Island (Rapa Nui) lies 3750 km west of the South American continent and 2250 km. East of the Pitcairn Islands. This island represents the most isolated landfall in the South Pacific Ocean along with its small rocky neighbor Salas y Gómez I. 415 km to the east. Although Easter Island is often regarded as part of the Indo-Pacific region, and most of its fauna consist of tropical species (in the case of shore fishes, 32.5%), it lies outside the 20° isotherm (Wells 1957) where seawater temperature and insolation are below that required for the development of structural coral reefs; water temperature can undergo interannual drops unfavorable to tropical organisms and may produce mass mortalities of corals (Wellington et al., 2001). The coral diversity on Easter Island is extremely low with only a few species of *Pocillopora* which undergo short-term population fluctuations, and one long-lived hermatype, *Porites lobata,* usually digitate, but having several variant forms (Glynn et al., 2003).

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The island hosts a diverse algal population (Santelices and Abbott, 1988), but its primary production is limited by low nutrient levels in the water typical of the mid-Southeast Pacific gyre in which it is situated (Moraga et al., 1999). The island's leafy algal species, primarily *Sargassum skottsbergi* and *Zonaria stipitata*, are unpalatable for most fishes and invertebrates as indirectly suggested by our personal observations, data reported below, and Duhart and Ojeda (1994). *Halimeda renschii* , often forming bright green bottom cover is probably of little nutritional value to the island fauna due to the intrinsic properties of the genus. Abundant algal detritus derived from *Zonaria* can be observed moving downslope in deeper sand-bottomed grooves perpendicular to the shore where it contributes to detrital food webs in waters below 50 m (DiSalvo et al., 1988). A popular cinematographic documentary by Jacques Cousteau clearly supported our contention of the impoverished nature of the undersea bench around Easter Island. An important characteristic of the island's submarine seascape, observed directly by the authors and verified in interviews with older local divers, has been major cyclical variation in substrata coverage by the macroalgae *Sargassum skottsbergi* and *Lobophora variegata* and that of corals of the genus *Pocillopora*. Presently no quantitative data on the extent and duration of these variations exists. One-time visitors to the island may over-or-underestimate the productive capacity of the island during times of either algal or coral abundance.

Our ecological reconnaissance at Easter Island (DiSalvo et al.,1988) was motivated by the lack of published information on the fauna of the island. This study produced many new records of species because we spent considerable resources and time in extending collecting efforts to previously unsampled depths and substrata as well as diving at night. Now, however, at least the shore fishes inhabiting waters of the Easter Island are well known, and the discovery of new records and species is limited mostly to the finding of "stray" species at the island or species that are cryptic and observed with difficulty under most circumstances (Randall and Cea 1989, Randall 2005).

The second author has had an interest in Easter Island fishes beginning with an expedition to the island in 1969 (Randall 1970) and the third author, as physician and director of the Easter Island Hospital, was resident on the island for eight months from 1967-to-1968, followed by over 30 visits during the subsequent three decades. During this time he was able to make extensive observations on the Easter Island fish fauna while diving. These two authors, with the helpful cooperation of resident fishermen and divers, produced a list of names for most of the local fishes in the Rapa Nui language (Randall and Cea, 1984) showing that most of the fishes were traditionally known to the Easter Islanders. A recent comprehensive listing of the shore and epipelagic fishes of Easter Island (Randall et al., 2005) includes the history of ichthyological studies at the island.

The fish fauna of Easter Island is impoverished compared with other islands in the Indo-Pacific region with a total to date of 162 inshore and pelagic species of which 126 are shore fishes. In Hawaii, which is as isolated as Easter Island in terms of distance to the nearest other islands or continents, the comparable value for inshore fishes is 612 species (Randall, 2007).

Since our survey publication (DiSalvo et al., 1988), new data have become available on oceanographic characteristics of the sea around Easter Island, including nutrients, temperature and currents (Moraga et al., 1999). Other studies have added knowledge of faunal groups of the island such as the sponges (Desqueyroux-Faundez, 1990), corals (Glynn et al., 2003), molluscs (Raines, 2002) and macrocrustaceans (Poupin, 2003) as well as certain less conspicuous groups including the Foraminifera (Zapata and Olivares 2000), the Ostracoda (Whatley et al., 2000) and the Isopoda (Kensley, 2003).

Because our knowledge of the specific composition of the inshore marine life of Easter Island is more definitive now than it was when we began 22 years ago, we now direct our observations to interactions among its marine biota. Among the most fundamental are the trophic interrelationships. In the present paper we present our analysis of the stomach contents of fishes that we collected or were obtained from the island's fishermen during our expeditions there in 1985 and 1986 (DiSalvo et al.,1988). We are aware of only one study that dealt with carnivorous food habits of fishes in the region, that of Pequeño and Mejias [UNPUB.MS] on *Seriola lalandi*, *Acanthocybium solandri* Cuvier, and *Thunnus albacares* Bonaterre caught from nearby Salas y Goméz Island. A second study (Duhart & Ojeda, 1994) presented important data on the foods of the two most common herbivorous fishes at the island, *Acanthurus leucopareius* and *Kyphosus pacificus*.

METHODS

Smaller fishes collected for the food-habit study were obtained mainly with the use of rotenone. Any freshly ingested prey that might have succumbed first to the ichthyocide had to be discounted. Larger fishes were speared or obtained from fishermen. Among those from fishermen were the jack *Caranx lugubris*, which they hook mainly at night, the bigeye *Cookeolus japonicus* (from 310 m) and the boarfish *Pentaceros decacanthus* from 520 m. Fish specimens were placed in ice chests prior to dissection. The stomachs were dissected while the specimens were fresh, and the contents were preserved in 70% ethanol for later sorting and identification at the first author's laboratory in Coquimbo, Chile. Most invertebrates mentioned appear in the lists published in DiSalvo et al. (1988). Visual approximation of the relative volumes of the different food organisms was made when possible (Hyslop, 1980). Some of the prey animals were sent to experts for identification. Specialists who identified invertebrates are listed in DiSalvo et al. (1988). Notes on feeding behavior are based on direct observations by the authors, as well as verbal information from Easter Island fishermen and divers. Scientific names and authorities for all the fishes mentioned in this study are given in Randall et al. (2005), for the Crustacea, excepting Cirripedia, in the review of Poupin (2003), for algae in Santelices & Abbott (1988), for Echinodermata in Di Salvo et al. (1988), for Mollusca in Rehder (1980) and Raines (2002), for corals in Glynn et al. (2003) and for Polychaeta in Cañete (1989).

RESULTS AND DISCUSSION

Food-habit data were obtained for 42 species of Easter Island fishes. A total of 127 stomachs were examined of which 18% were empty. Results of the analyses are listed in the Appendix, including mention of those fishes with empty stomachs. Many of the stomach contents were too digested to identify and some contents were too macerated by the feeding mechanisms of the fishes to attempt specific identification. A few data are included that represent direct observations by the authors of fishes feeding *in situ*.

The present results are similar to those presented for comparable fish families in the extensive report made on the feeding habits of Marshall Islands fishes by Hiatt & Strasburg (1960) on 127 genera and 233 species of fishes. Comparisons of our results with those of the preceding reference are of interest in emphasizing the low fish diversity at Easter Island as the coral reef region studied by Hiatt and Strasburg is now known to support upwards of 1000 species of inshore fishes.

Observations on Fish Feeding Habits

The lizardfish *Synodus capricornis* was solitary and sedentary in shallow water, relying on its apparent immobility to seize unsuspecting prey which at Easter Island as in other locations are small fishes.

The cornetfish *Fistularia commersoni* is another important predator at the island. Although generally found near the substratum, the third author often observed it at the surface at Easter Island. This may be due to its finding suitable prey there while not being threatened by large predators.

Aulostomus chinensis was a fairly common bottom-oriented predator often seen near caves as shown by its stomach contents of cave-associated fishes and crustaceans.

The two small serranids of the island were few and retiring, with the endemic *Acanthistius fuscus* often in caves. The small cave-dwelling slipper lobster *Parribacus perlatus* found in one stomach is also endemic.

The only latridid from the island, *Goniistius plessisi,* contained a variety of prey species with crustaceans dominant. Randall (1983) previously reported the stomach contents of five individuals of this species to contain 39% by volume of alpheid shrimps, 38% crabs, 5% unidentified crustaceans, 5.5% small gastropods, and the remainder bryozoan, ophiuroid, foraminiferan, unidentified animal material and a trace of bottom sediment. This species probably feeds at night or in the early morning as specimens collected in the afternoon contained material only in the intestines. One specimen in the present study contained numerous individuals of *Phylladiorhyncus* (a small galatheid crab) which is a common infaunal inhabitant in relict *Pocillopora* skeletons. The small hawkfish *Itycirrhitus wilhelmi*, not common at the island, was most often seen immobile on living *Porites* coral. Stomachs of these fishes contained many small unpigmented crustaceans.

The two inshore species of priacanthid fishes, populous at Easter Island in the numerous shallow caves by day, are feeders on zooplankton at night, particularly on

crab megalopae. The deep-dwelling (310 m) *Cookeolus japonicus* contained isopod crustaceans about 10x larger (20 mm) than any previously reported free-living isopods from the island (Kensley, 2003); their stage of decomposition unfortunately rendered them unidentifiable.

Among the carangids, the jack *Caranx lugubris*, which is common around the island, contained mainly fishes. Six of these jacks, however, had eaten the stomatopod *Odontodactylus hawaiiensis* (adult specimens, 40-50 mm in length) which was a new record for this species at the Island. The stomachs of another common carangid fish, *Pseudocaranx cheilio* (reported as *P. dentex* in Randall et al. 2005), a bottom feeder, contained large amounts of inert sedimentary material plus several previously unrecorded species of small, sand-dwelling molluscs recently collected by dredging (Raines, 2002). One of the five specimens of the fast-swimming carangid *Seriola lalandi* that we examined contained the triggerfish *Xanthichthes mento* as previously noted at Salas y Gómez Island by Pequeño and Mejias [UNPUB. MS].

The goatfish *Mulloidichthys vanicolensis*, uncommon at Easter Island, ranged over the bottom, probing sediments, which at Easter Island which we noted during our collecting efforts on the two expeditions, were notoriously low in invertebrate content as compared with our personal observations on Pacific, Indian Ocean, and Carribean coral reefs. In Hawaii this species feeds mainly at night (Gosline & Brock, 1960). We noted nonfeeding aggregations at Easter Island during the daylight hours but did observe one subadult feeding in a sand area at 1700 hrs.

The wrasses are comparatively well represented at Easter Island with 10 species, considering the limited fish diversity . They are active fishes closely associated with the substratum.

The endemic *Coris debueni* is one of the most common and ubiquitous fishes at the island. Stomach contents revealed it to be most successful feeding on molluscs but it also ingested crustaceans and echinoderms. The smaller *Anampses femininus* forages in small groups over rocky substrata. Our limited food-habit data indicate that it feeds mainly on a wide variety of small benthic crustaceans ingesting some bottom sediment. It was surprising that two individuals of *Thalassoma lutescens* contained significant amounts of *Pocillopora* coral tips, as labrids are not known to be coral feeders. The two larger, solitary wrasse species were not common. *Bodianus vulpinus*, typically from 5-20 m depths, had fed on molluscs, crustaceans and unexpectedly, an entire, though small, *Diadema* urchin. The slow-swimming *Pseudolabrus semifasciatus* was not observed at less than 40 m depth and was taken by hook-and-line as deep as 250 m. Its stomach contents contained molluscan remains typical of shallow (< 10m) water suggesting, in agreement with the “niche release” concept developed by Kohn (1978) for *Conus miliaris pascuensis*, that several of the mollusc species collected by us in shallow water also extend downward into the deeper feeding range of this wrasse.

The presence of turf-algal feeders such as *Acanthurus leucopareius* was favored by the well-developed algal turfs in areas unaffected by urchin grazing supporting the commonly seen schools of these fishes on Easter Island as detailed by Duhart & Ojeda (1994). Numerous tiny infaunal organisms associated with the algal turf community were common in the stomachs of these fishes, and these may have provided important trace inputs to their nutrition.

None of the five monacanthid fishes at Easter Island are common. Fishes of this family are known to contain a wide variety of plant and animal material in their digestive tracts and our limited data indicated the same. One of our two specimens of *Cantherhines dumerilii* had eaten only the tips of *Pocillopora damicornis*. The second author examined the stomach contents of eight specimens of this filefish from other Pacific island localities and found that branching corals of four different genera were the dominant food items. The puffer *Arothron meleagris* was common and is often observed in shallow caves. It emerged to bite at coral, asteroids and other prey which were obtained with difficulty due to their physically resistent structural nature (*e.g.*urchins), protective shells or coverings (*e.g.* barnacles), or firm attachment to the substrate (*e.g. Antisabia* and *Pilosabia* limpets). The long spined porcupine fish *Diodon holocanthus* was observed most commonly in open water. Stomachs of this species also contained a high percentage of hard-shelled prey items but did not contain coral.

The Fishes as Participants in the Easter Island Ecosystem

With only 126 species of shore fishes, Easter Island has the most impoverished' fish fauna of any locality in the Indo-Pacific region. The same appears evident for the invertebrate fauna and the algal flora. Randall et al. (2005) discussed the combination of factors that has resulted in the paucity of fish species, the foremost being the extreme geographic isolation of the island coupled with its being the most distant from the Indo-Malayan region, the richest faunal marine province in the world. Also important are the islands' relative youth (2.5 million years), its small size (hence a small target for larval forms drifting from distant localities), the limited diversity of marine habitats and its subtropical location. A protracted period of low sea temperature (one record of 15.7°C reported by DiSalvo et al. 1988) could result in local extinction of tropical Indo-Pacific species and abnormally high temperature (Wellington et al., 2001) could endanger subtropical species adapted to cooler seas. Obvious variations were noted in the marine biota over the period of years that the authors have visited the island. In 1969 when the second author first went to Easter Island, he noted vast meadows of *Sargassum skottsbergi*. Two species of herbivorous fishes were abundant, including the nibbler *Girella nebulosa* and the parrotfish *Leptoscarus vaigensis*. In 1985 and 1986 when the three of us conducted our fieldwork at the island, the alga *Sargassum skottsbergi* was only present in small patches, neither of the above two species of fishes were seen and the *Pocillopora* spp. corals were clearly more populous than previously observed. Extreme fluctuation in the numbers of the kyphosid fish *Kyphosus pacificus* is well known to the islanders, as it is a staple food fish. This species is actively sought by spearfishermen who correlate its scarcity with the periodic declines in its main forage *Lobophora variegata.*

Some families of Indo-Pacific shore fishes are not represented by any species at Easter Island. Examples of families absent from the island but present at the Pitcairn Islands, the nearest island group to the west, are the Platycephalidae, Caracanthidae, Pseudochromidae, Caesionidae, Lethrinidae, Mugilidae, Pempheridae, Pinguipedidae, Tripterygiidae, Microdesmidae and the Siganidae. During our visits we found so

few specimens of some species of fishes that it was assumed they were probably not represented by breeding populations at the island. Examples of such “strays” are the butterflyfish *Amphichaetodon melbae* of which we observed three on one visit to the island, and collected only a single specimen on another. This butterfly fish occupied cooler water below 50 m. and is otherwise known only from the island of San Felix off the coast of Chile. A stray from the west was *Chaetodon smithi* otherwise known from Rapa and the Pitcairn Islands.

Dietary overlap was seen where various species of fishes contained remains of the same species of molluscs, notably the small conch *Strombus maculatus*, and the very small mussels, *Septifer bryani* and *Modiolus matris*. Our unpublished collection data from 1985 and 1986 showed these species to be common in collections from various depths around the island with *S. maculatus* one of the most common molluscs; veliger larvae of this species formed the bulk of stomach contents of one specimen of *Xanthichthys mento*. Other species of molluscs at the island, which were relatively common (although diminutive), including small infaunal bivalves of the genera *Promantellum*, *Lima*, *Hiatella* and *Malleus*, also were found in fish stomachs. The brittle stars *Ophiocoma dentata* and *O.longispina* occasionally found in various fish stomachs were more common than asteroids on the island probably because of their adaptations for feeding on particulate foods rather than macroscopic prey.

We note here the unusually small size of many of the invertebrates of Easter Island as compared with the first author’s observations of infaunal invertebrates during extensive collecting efforts on tropical Pacific coral reefs. Several of the ophiuroid species which we collected (some as yet undescribed) are 10-20 millimeters in maximum dimension. One of the three endemic starfish species does not exceed 40 mm in major dimension. Many of the molluscs described by Rehder (1980), plus the 25 species reported by Raines (2002), are just a few millimeters in length. Many of the (as yet undescribed) nudibranchs we collected did not exceed 3 mm in length. Species of polychaetes at the island do not normally exceed 10 mm in length except for *Loimia medusa* which can reach major proportions due to its capacity to extract nutrition from particulate benthic deposits including microorganisms. Most of the crab species from the island are less than 30 mm in carapace width and all the isopods described previous to the present study measured a maximum of 3 mm. in length (Kensley, 2003).

A few of the fish stomachs yielded surprises in the form of previously unreported or new species. An unusual observation was the was finding of fragments of the black sponge *Amphimedon sp.* in the stomachs of *Lactoria diaphanus;* several of these sponge fragments enveloped individuals of the newly described barnacle *Globiverruca spongophila* (Young, 2004), an obligate sponge symbiont listed as unidentified by DiSalvo et al. (1988). This sponge has been found in the stomachs of several other fish species such as *Chaetodon litus.* This butterflyfish may have been foraging for these barnacles as *Chaetodon* species are not known normally to feed on sponge. Other examples linking endemic fishes and endemic prey include the common wrasse *Coris debueni* feeding on the gastropods *Pascula citrica* and *Nodichila pasca,* the hermit crab *Calcinus pascuens,* and the bivalves *Lima disalvo* and *Pascahinnites pasca.*

The stomach contents data reported by Duhart & Ojeda (1994) suggested that at least one turf-feeding herbivorous fish (*Acanthurus leucopareius*) was selecting

particular algal species from the diverse but diminutive algal flora of the island. It was notable that most herbivore stomachs did not contain *Zonaria* and *Halimeda* which were abundant almost everywhere except on the "barren grounds" created by the numerous *Diadema sp.* sea urchins observed in 1985 and 1986.

We did not observe benthic surfaces denuded by herbivorous fishes as conjectured by Glynn et al. (2003) who suggested these fishes might facilitate the recruitment of coral larvae on cleaned surfaces. It was obvious that the large numbers of sea urchins that we observed during our visits in 1985 and 1986 were responsible for leaving denuded surfaces upon which active recruitment of corals of *Pocillopora* spp. were observed. The parrotfish, which are notable for scraping coral and algal surfaces on coral reefs, are absent from Easter Island except for the small rarely seen *Leptoscarus vaigensis*. Success of some of the fishes such as the Tetraodontidae and Diodontidae is due to their capacity for biting off physically resistent prey items such as corals, barnacles, echinoderms and the firmly attached filter-feeding limpets *Pilosabia* and *Antisabia*. Other fishes such as those of the Ostraciidae survive by feeding on such unpalatable organisms as sponges. Fishes that range to the deeper slopes around the island were able to capitalize on larger invertebrate prey such as the stomatopods found in carangids and the shrimp *Plesionika edwardsi* in *Pentaceros*. These crustaceans are probably supported by the deeper slope detrital food webs postulated by DiSalvo et al. (1988). A trophic linkage between fishes and detrital feeders was noted with *Chaetodon litus*, the stomachs of which often contained masses of tentacles from the polychaete *Loimia medusa*. Tentacle feeding by large specimens of this polychaete was most commonly observed during night dives of 20-40 m on sandy bottoms where algal detritus was common.

Perhaps the most common fish at Easter Island is the small endemic goby *Pascua caudilinea* (Randall 2005) which was never seen alive while diving by day or night. It was found from tidepools to 40 m depths in keeping with the "niche release" concept of Kohn (1978). This concept was previously cited for this fish (as *Hetereleotris* sp.) plus another goby *Priolepis* sp. and the damselfish *Chrysiptera rapanui* (DiSalvo et al. 1988). The specimens of *Pascua caudilinea* that we collected ranged from 8-to-28 mm in length. They live in cryptic spaces within relict coral skeletons as part of an infaunal assemblage. This species probably feeds on tiny crustaceans such as the isopods (Kensley, 2003) and other very small infaunal organisms observed to be present (DiSalvo et al. 1988), some of which currently remain undescribed.

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REFERENCES

Cañete, J.
1989. Taxonomia y biogeografia de polyquetos bentonicos de la Isla de Pascua. Tesis de Licenciatura, Facultad de Ciencias Marinas, Universidad Catolica del Norte, Coquimbo, Chile. vi + 240 pp.

Desqueyroux-Faundez, R.
1990. Spongiaires (Demospongiae) de l'Ile de Paques (Isla de Pascua). *Revue Suisse de Zoologie* 97: 373-409.

DiSalvo, L.H., J.E. Randall and A. Cea
1988. Ecological reconnaissance of the Easter Island sublittoral marine environment. *National Geographic Research* 4:51-473.

Duhart, M. and F.P. Ojeda
1994. Caracterización ictica de pozas intermareales y analisis trofico de peces herbivoros submareales de la Isla de Pascua . *Medio Ambiente* 12:32-40.

Gosline, W.A. and V. Brock
1960. Handbook of Hawaiian Fishes. University of Hawaii Press, Honolulu, Hawaii, USA. 372 pp.

Glynn, P.W., G.M. Wellington, E.A. Weiters, and S. Navarrete
2003. Reef building coral communities of Easter Island (Rapa Nui), Chile. In: Cortes, J. (ed) *Latin American Coral Reefs*: 473-494. Elsevier Science Press, Amsterdam, Netherlands.

Hiatt, R.W., and D.W. Strasburg
1960. Ecological relationships of the fish fauna on coral reefs of the Marshall Islands. *Ecological Monographs* 30:65-127.

Hyslop, E.J.
1980. Stomach contents analysis-a review of methods and their application. *Journal of Fish Biology* 17:411-429.

Kensley, B.
2003. Marine isopod crustaceans from Easter Island. *Pacific Science* 57:287-317.

Kohn, A.J.
1978. Ecological shift and release in an isolated population: *Conus miliaris* at Easter Island. Ecological Monographs 48:323-336.

Moraga, J., A.Valle-Levinson, and J.Olivares
1999. Hydrography and geostrophy around Easter Island. *Deep Sea Research* I-46: 715-731.

Poupin, J.
2003. Crustacea decapoda and stomatopoda of Easter Island and surrounding areas. A documented checklist with historical overview and biogeographic comments. *Atoll Research Bulletin* 500:1-50.

Raines, B.
2002. Contributions to the knowledge of Easter Island Mollusca. *La Conchiglia* (Rome) 34 : 11-40.

Randall, J.E.
1970. Easter Island : An ichthyological expedition. *Oceans* 3:48-59.

Randall, J.E.
1983. A review of the fishes of the subgenus *Goniistius*, genus *Cheilodactylus*, with description of a new species from Easter Island and Rapa. *Occasional Papers of the Bernice Pauahi Bishop Museum* (Honolulu, USA) 25(7):1-24.

Randall, J.E.
2005. *Pascua caudilinea*, a new genus and species of gobiid fish (Perciformes: Gobiidae) from Easter Island. *Zoological Studies* 44:19-25.

Randall, J.E.
2007 Reef and Shore Fishes of the Hawaiian Islands. Sea Grant College Program. University of Hawaii, Honolulu. xiv + 546 pp. , USA.

Randall, J.E. and A.Cea
1984. Native names of Easter Island Fishes, with comments on the origin of the Rapanui people. *Occasional Papers of the Bernice Pauahi Bishop Museum*. (Honolulu, USA) 25(12): 1-16 .

Randall, J.E and A.Cea
1989. *Canthigaster cyanetron,* a new toby (Teleostei:Tetraodontidae) from Easter Island. *Revue Francaise Aquariologie* 15:93-96.

Randall, J.E., A. Cea, and R.Melendez
2005. Checklist of shore and epipelagic fishes of Easter Island, with 12 new records. *Boletin del Museo Nacional de Historia Natural*, Chile. 54:41-55.

Rehder, H.A.
1981 The marine molluscs of Easter Island (Isla de Pascua) and Sala y Gomez. *Smithsonian Contribution to Zoology* 289:1-167.

Santelices, B. and I.A. Abbott
1988. Geographic and marine isolation: an assessment of the marine algae of Easter Island. *Pacific Science* 41:1-20.

Wellington, G., P.W. Glynn, A.E. Strong, S.A. Navarrete, E. Weiters and D. Hubbard
2001. Crisis on coral reefs linked to climate change. *Eos*, Transactions, American Geophysical Union, 82:1-5.

Wells, J.W.
1957 Coral reefs. In: J.W. Hedgepeth (ed) Treatise on Marine Ecology and Paleoecology:609-631. *Geological Society of America Memoir* No. 67 (I), Washington DC, USA.

Whatley, R., R Jones and K. Wouters
2000. The marine Ostracoda of Easter Island. *Revista Española de Micropaleontologia* 32:79-106.

Young, P.
2004. *Globuloverruca spongiphila gen*.nov., *sp*.nov. A sponge-associated verrucid (Crustacea:Cirripedia:Thoracica) from Easter Island with discussion on the morphology of the plate tubules. *Zootaxa* 420:1-10.

Zapata, J. and J. Olivares
2000. Biodiversidad y Zoogeografia de los foraminiferos bentonicos de Isla de Pascua (27°10’S, 109°20’W),Chile. *Boletin de la Sociedad Biologica de.Concepción*. 71: 53-77.

APPENDIX

Stomach contents of inshore fishes collected at Easter Island, February 1985-1986 including visual estimates of percentage mass composition of material recovered from some stomachs, with some direct observations of feeding activity (*f*).
Distribution Key: **E**=endemic, **AT** = antitropical, **I-P** = Indo-Pacific, **S** = southern subtropical, **C** = cosmopolitan.
Numbers in ( ) = number of individuals; ***p*** = specimens pooled; **—** = no data.

Family/Species	**Distribution**	**Standard length - mm**	**Stomach Contents**
SYNODONTIDAE (LIZARDFISHES)			
Synodus capricornis	**AT**	247	none
" "	"	(3) 130-185	two with fish remains
" "	"	—	*Decapterus muroadsi* (*f*)
FISTULARIIDAE (CORNETFISHES)			
Fistularia commersonii	**I-P**	(2) 820, 990	none
" "	"	475	fish remains
" "	"	—	*Decapterus muroadsi* (*f*)
AULOSTOMIDAE (TRUMPETFISHES)			
Aulostomus chinensis	**I-P**	405	*Pseudolabrus fuentesi*, 47 mm 60% rock shrimp *Rhyncocinetes balssi*, 33 mm 40%
" "	"	470	fish, unid. 67% stomatopod *Pseudosquilla oculata*, 30 mm. 33%
" "	"	495	juv.*Chaetodon litus*, 35mm
" "	"	545	fish, *Apogon sp.*
" "	"	535	stomatopod, unid.
" "	"	562	unid. fish remains
" "	"	755	fish, *Myripristis tiki*, 154 mm
" "	"	526	stomatopod, unid. 70%. fish , unid 30%

APPENDIX, CONTINUED

Family/Species	**Distribution**	**Standard length - mm**	**Stomach Contents**
" "	"	600, 728, 528, 725	no contents
SCORPAENIDAE (SCORPIONFISHES)			
Scorpaena orgila	**E**	292	fish bones, unid.
SERRANIDAE (GROUPERS AND ALLIES)			
Acanthistius fuscus	**E**	250	slipper lobster *Parribacus perlatus* 50mm crab, unid. 50mm
" "	"	252	crab, unid., 25 mm
" "	"	255	no contents
Trachypoma macracanthus	**S**	165	crab, unid.
CIRRHITIDAE (HAWKFISHES)			
Itycirrhitus. wilhelmi	**S**	(3***p***) 70-104	small crustaceans, various, unid., crab chela
LATRIDAE (MORWONGS)			
Goniistius plessisi	**S**	242	crab remains, numerous (*Phylladiorhyncus serrirostris*), unid. xanthid crab 50% shrimp remains, alpheid, unid. shrimp 30% crustacean remains (various taxa) 15% foraminifera, unid. chitinous matter 5%
" "	"	257	crab, 30mm xanthid unid.

APPENDIX, CONTINUED

Family/Species	**Distribution**	**Standard length - mm**	**Stomach Contents**
" "	"	317	crab and shrimp remains, unid. 50% 7 irregular echinoids, 3.5-9 mm (*Echinoneus cyclostomus)* 30% 15 bivalves, 3-8 mm *(Limaria fragilis*) 10% gastropods, (*Emarginula velascoi*, *Retusa pusilla*, and unid. spp. 10% fine bottom sediment trace
" "	(2*p*)	260, 285	infaunal crustaceans 75% infaunal molluscs 20% other (irreg. echinoids, sediments) 5%
PRIACANTHIDAE (BIGEYES)			
Cookeolus japonicus	**C**	420	no contents
" "		428	isopods, unid. ~20 mm.
Heteropriacanthus cruentatus	**C**	217	8 crab megalopae
" "	"	193	crab megalopae 90% misc.: postlarval fishes isopod, lobster juv. 10%
Priacanthus nasca	**E**	185	crab megalopae and shrimp larvae, larval fishes
" "		180	5 crab megalopae
" "		205	crab megalopae 90% stomatopod postlarvae 10%
CARANGIDAE (JACKS) [lengths = fork length]			
Pseudocaranx cheilio	**AT**	397	stomatopod *Pseudodosquilla oculata* (40mm), crab fragments 20%
" "		467	molluscs: *Natica ochrostomata*, (5 mm.) *Strombus maculatus* *S.maculatus* fragments,

APPENDIX, CONTINUED

Family/Species	Distribution	Standard length - mm	Stomach Contents
			Favartia rosamiae, *Cadella mauia, Elliptotellina caelata* & stomatopod parts 20% coarse calcareous sediment 80%
" "		462	3 *Chaetodon litus* (32-36 mm)
" "		(3) —	no contents
" "		—	stomatopod remains, unid. coarse calc. sediment
Decapterus muroadsi	**AT**	620	flying fish (*Exocoetus*?), fish remains, unid., crustacean remains
" "		386	mass of crab megalopae, unid. zooplankton
Caranx lugubris	**C**	—	stomatopod, unid. (40 mm.)
" "		—	fragments of stomatopod *Odontodactylus hawaiiensis*
" "		(2) 380	unid. digested material
" "		360	unid. crustaceans (incl. isopods)
" "		400, 460, 500, 570	all with unid. fish remains
" "		460, 520	each with 1 stomatopod, *O. hawaiiensis*
" "		650	*Aulostomus chinensis* 350 mm.
" "		—	stomatopod remains, unid
" "		(8***p***)	fishes, including *Lobianchia gemellaria* (myctophid) *Xanthichthys mento, Myripristis tiki, Sargocentron wilhelmi, Bathystethus orientalis, Emmelichthys karnellai*
" "		(8)	no contents unid. fish, aprox 15 cm
Elagatis bipinnulata	**C**	620	fish remains, unid., *Exocoetus*, crustacean remains unid.
" "		698	zooplankton misc., unid.
Seriola lalandi	**AT**	615, 940	fish remains, unid.

APPENDIX, CONTINUED

Family/Species	Distribution	Standard length - mm	Stomach Content
" "		790	3 *Xanthichthys mento,* 90-148 mm.
" "		940	fish remains, (*Decapterus* 62mm, flying fish) & small crustaceans unid.
" "		694	no contents
MULLIDAE (GOATFISHES)			
Mulloidichthys vanicolensis	**I- P**	240	irreg. echinoids (7mm), unid. filaments, juvenile clam, foraminifera
" "		235	crab chelae (calappid, xanthid, portunid) 50% 3 *Brissus* sp. echinoids (4-6mm) 25% clams (3 mm) & other mollusc remains 25% bottom sediment trace
Parupeneus orientalis	**E**	200	2 xanthid crabs, *Thalamita* sp.crab unid. macruran, unid. crustaceans
" "		203	unid. waxy amorphous material (molluscan egg mass ?)
GIRELLIDAE (NIBBLERS)			
Girella nebulosa	**E**	—	algae *Lobophora variegata* (*f*)
KYPHOSIDAE (RUDDERFISHES)			
Kyphosus pacificus	**I-P**	225	*Lobophora variegata* 90% misc.epibionts, forams 10%
" "		360	*L. variegata*
" "		271	*L. variegata* 99% epibionts,fish eggs, alciopid polychaete 1%

APPENDIX, CONTINUED

Family/Species	**Distribution**	**Standard length - mm**	**Stomach Contents**
CHAETODONTIDAE (BUTTERFLY FISHES)			
Forcipiger flavissimus	**I-P**	105	juv.ophiuroid *Ophiocoma longispina,* crab & cirriped fragments, algal filaments polychaetes, forams 50% sponge (*Asteropus* sp.) 50%
" "		170	black pigmented material (unid.) , 4 alpheid shrimp, unid. egg (white), sponge spicules, crustacean fragments, foraminifera, bottom sediment particles
Chaetodon litus	**E**	98	terebellid polychaete (*Loimia medusa*) 70% shrimp *Thor* sp., fish eggs 10% yellow amorphous mat 20%
" "		100	polychaete *L. medusa*, tentacles only 70% sponge, keratose (tan color) & unid.mat. 30%
POMACANTHIDAE (ANGELFISHES)			
Centropyge hotumatua	**S**	—	filamentous turf algae
PENTACEROTIDAE (BOARFISHES)			
Pentaceros decacanthus	**D**	296	1 pandalid shrimp, *Plesionika edwardsi*
POMACENTRIDAE (DAMSELFISHES)			
Stegastes fasciolatus	S	97	filamentous turf algae 70% unid. egg strings, serpulid polychaete tubes 30%
" "	**(*p*)**	120,134	algal filaments (*Cladophora*?) crustacean eyes, very small unid. molluscs 95% forams, sand 5%

APPENDIX, CONTINUED

Family/Species	**Distribution**	**Standard length - mm**	**Stomach Contents**
LABRIDAE (WRASSES)			
Anampses femininus	**S**	(pooled)126,177	amphipods, isopods, alpheid chela, & unid crustacean fragments 55% decapod chela portunid), *Thalamita* crab,crab parts 40% foraminifera, sediment 5%
Bodianus vulpinus	**S**	305	decapods, alpheids and other shrimp fragments, 1 R*hincocinetes balssi* 70% *Strombus maculatus*, *Pascula citrica* & unid. mollusc fragments 30%
" "		315	entire juv. *Diadema* 90% molluscs: *Septifer bryani*, *Pascula citrica, Strombus maculatus* (frag.) 10%
Pseudolabrus semifasciatus	**E**	198	*Strombus maculatus* fragments 50% *Septifer bryani* fragments 15% Alpheid shrimp, unid. crab fragments 35%
" "		208, 230	no contents
Coris debueni	**E**	—	*Septifer bryani* 3-8 mm. 40% *S. maculatus*, *P. citrica, Nodichila pasca* 40% hermit crab *Calcinus pascua* 10% irregular echinoid, *Echinoneus* sp. 10%
" "		—	molluscs (as fragments) *Modiolus matris Pascahinnites pasca*, *Promantellum* sp., unid. bivalves & gastropods 99% decapod fragments, sediment 1%

APPENDIX, CONTINUED

Family/Species	Distribution	Standard length - mm	Stomach Contents
" "		(3 ***p***) 184-210	*Ophiocoma dentata* 25% *P. citrica*, *S. bryani*, *Neothais nesiotes*, *Diodora granifera*, *Hiatella* sp., *Malleus* sp. & unid. mollusc 30% crustacean fragment, *Trapezia*. & crust. parts 40% *Diadema* spines 5%
" "		(7 ***p***) 195-205	*Lima disalvoi*, unid.bivalves 45% hermit crabs 10% echinoid test 5% *S. maculatus* 40%
Pseudolabrus fuentesi	**S**	—	crab & crustacean parts 70% juv. *S maculatus* 5% bivalves , *S. bryani* & unid. bivalve fragments 25%
" "		—	*Septifer bryani* 50% xanthid crabs 30% *Ophiocoma longispina* spines, cirriped, gastropod *Euchelus (Herpetopoma) alarconi* unid. crab 20%
" "		141	*Petrolisthes* sp.crab, *O. longispina* spines, crab appendages, *Strombus maculatus* fragments
" "		(3) 141-156	no contents
Thalassoma lutescens	**I-P**	162	crab: *Petrolisthes, Thalamita,* portunid parts 60% cirriped fragments 20% shell fragments, bivalve & gastropod, ophiuroid spines 20%
" "		198	coral *Pocillopora damicornis* tips 30% juvenile *Diadema* 20% crab fragments, *Calcinus* & portunid 10% cirriped: (*Euraphia*) parts 20% mollusc: *Malleus*, gastropod fragments 10% unidentified filamentous mass 10%

APPENDIX, CONTINUED

Family/Species	Distribution	Standard length - mm	Stomach Contents
" "		(3 ***p***) 152-205	coral, *Pocillopora* sp. 20% crabs, juvenile, unid. 35% cirriped (Euraphia) 20% molluscs, unid. 15% Echinoid :*Brissus* sp. 10%
Xyrichtys koteamea	**E**	200	no contents
ACANTHURIDAE (SURGEONFISHES)			
Acanthurus leucopareius	**AT**	(3)152-200	turf -forming algae: (*Padina, Dictyota* , *Zonaria* spp., filamentous & calcarous reds 95% other: foraminifera, sponge, *Halimeda,* sediment 5%
" "		(3) —	turf-forming algae filamentous monospecific, (unid.) 99% other: *Acetabularia* sp., *Halimeda,* microcrustacea, polychaete tubes, sediments 1%
SPHYRAENIDAE (BARRACUDAS)			
Sphyraena helleri	**I-P**	534	12 half-digested flyingfishes, unid. (80-100mm)
BOTHIDAE (LEFT-EYE FLOUNDERS)			
Bothus mancus	**I-P**	243	3 *Pseudolabrus fuentesi* 25-38 mm
" "		235	no contents
BALISTIDAE (TRIGGERFISHES)			
Xanthichthys mento	**AT**	184	zooplankton: amphipods, copepods, lobster phyllosoma larvae, molluscan veligers polychaetes, fish eggs

APPENDIX, CONTINUED

Family/Species	Distribution	Standard length - mm	Stomach Contents
" "		132	veliger larvae (gastropod & bivalve) 50% fish eggs 20% other: copepods, sponge spicules, gastropod veligers 30%
MONACANTHIDAE (FILEFISHES)			
Aluterus monoceros	**C**	395	5 crab megalopae & stomach full of soft, amorphic mat.
Cantherhines dumerlii	**I-P**	227	*Pocillopora damicornis* (tips)
" "		310	filamentous turf algae 50% foraminifera 20% didemnid ascidians 10% sponge 10% other algal infauna: ophiurioid, echinoid, gastropod, amphipod 10%
Cantherines rapanui	**E**	142	filamentous turf algae, cirripeds (2), didemnid ascidians, 75% *Malleus* sp., forams 10% sand-covered egg capsules 10% fine sediment 5%
" "		134	echinoid *Echinostrephus aciculatus*, hydroid, unid.
" "		(***p***) 147,157	filamentous turf algae, *Halimeda* 50% foraminífera 50%
OSTRACIIDAE (BOXFISHES)			
Lactoria diaphanus	**AT**	—	black sponge, tan sponge 75% sponge-symbiotic barnacles *Globiverruca* 10% 2 limpets, *Williamia polinesica* 10% misc. amphipods, foraminifera 5%

APPENDIX, CONTINUED

Family/Species	Distribution	Standard length - mm	Stomach Contents
" "		210	unid. material (egg mass?) in filamentous material 70% large sedimentary fragments-volcanic & calcareous (to 5 mm) 20% 2 bulliform mollusc shells, unid., & misc. small crustaceans, urchin spines, *Halimeda* sp. 10%
" "		220	green algal tufts (cf *Cladophora* sp.) 20% polychaetes in tubes *Sigalianidae, Palola siciliensis,L.medusa)* 80%
" "		—	(all remains macerated) mollusc 50% crab 25% urchin 10% misc.: polychaete setae, algae tufts, sediment 15%
TETRAODONTIDAE (PUFFERS)			
Arothron meleagris	**I-P**	272	*Porites lobata* 70% asteroid *Leiaster leachii* 20% misc: echinoid, forams, *Pocillopora damicornis* 10%
" "		220	*Porites lobata* 20% *Leiaster leachii* 25% cirriped *Rehderella belyaevi* 15% sponge,unid. 30% misc: *Septifer bryani*, *Pocillopora*, forams ascidians, echinoid 10%
" "		—	sponge , unid. 40% *Porites lobata* 45% *P. damicornis* 10% misc: hermit crab, foraminifera, *Ophiocoma* 5%
" "		280	*Porites lobata*

APPENDIX, CONTINUED

Family/Species	Distribution	Standard length - mm	Stomach Contents
" "		285	*Porites lobata* 15% asteroid *Astrostole paschae* 35% sponge, unid. 50%
" "		255	*Porites lobata* 60% sponge, 2 spp., unid. 40%
" "		270	*Astrostole paschae* 40% sponge, unid. 10% polychaetes (*Serpulidae*) 10% *Rehderella belyaevi* 40% 1 small hermit crab, unid. trace
DIODONTIDAE (PORCUPINE- AND BURRFISHES)			
Diodon holocanthus	**C**	265	*Strombus maculatus* & hermit crabs *Calcinus pascuensis*
" "		(4*p*) 170-247	gastropods:*Antisabia*&*Pilosabia, Morula praecipua Imbricaria punctata* & unid bivalve: *Chama iostoma* (juv.) *Echinostrephus aciculatus* hermit crab *Calcinus* and xanthid crab parts polychaete tubes
" "		217	hermit crabs (*Calcinus* ?) 50% xanthid crab 30% *Morula praecipua* 20%
" "		(3*p*) —	mollusc fragments , unid. 40% crustacean parts, unid. 40% *Leiaster leachii* ray tips 15% misc.: algae, sediment 5%
" "		—	crab fragments, unid 20% molluscs: *Pilosabia.& Antisabia N. pascua, P. citrica* 80%
" "		(3*p*) 155-195	*Ophidiaster easterensis* 15% hermit crabs 20% mollusc shell fragments 60% limpets & *Lima disalvoi* 5%